SNF/HLW Dual and Multi Purpose Casks Issues

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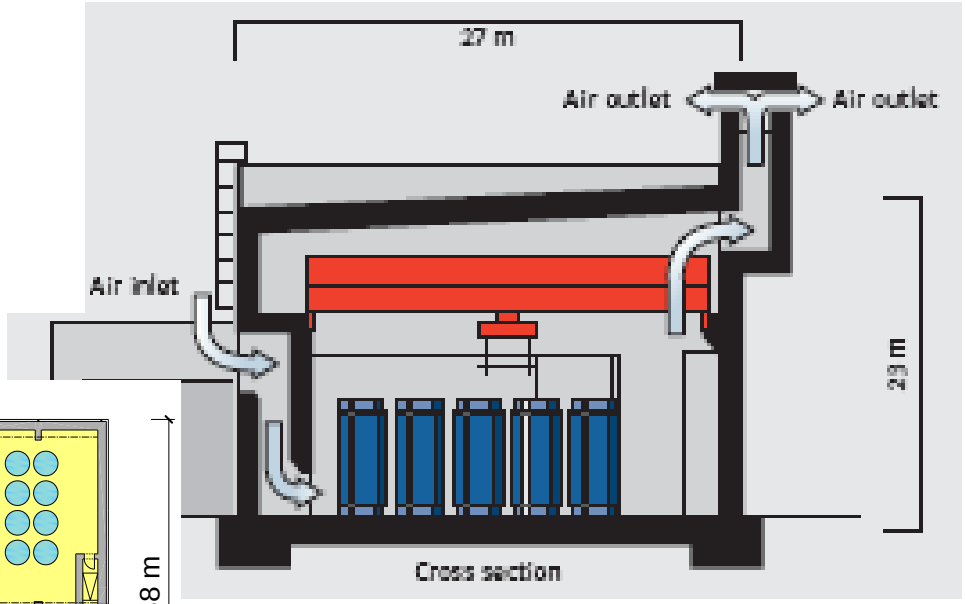
Presentation Outline

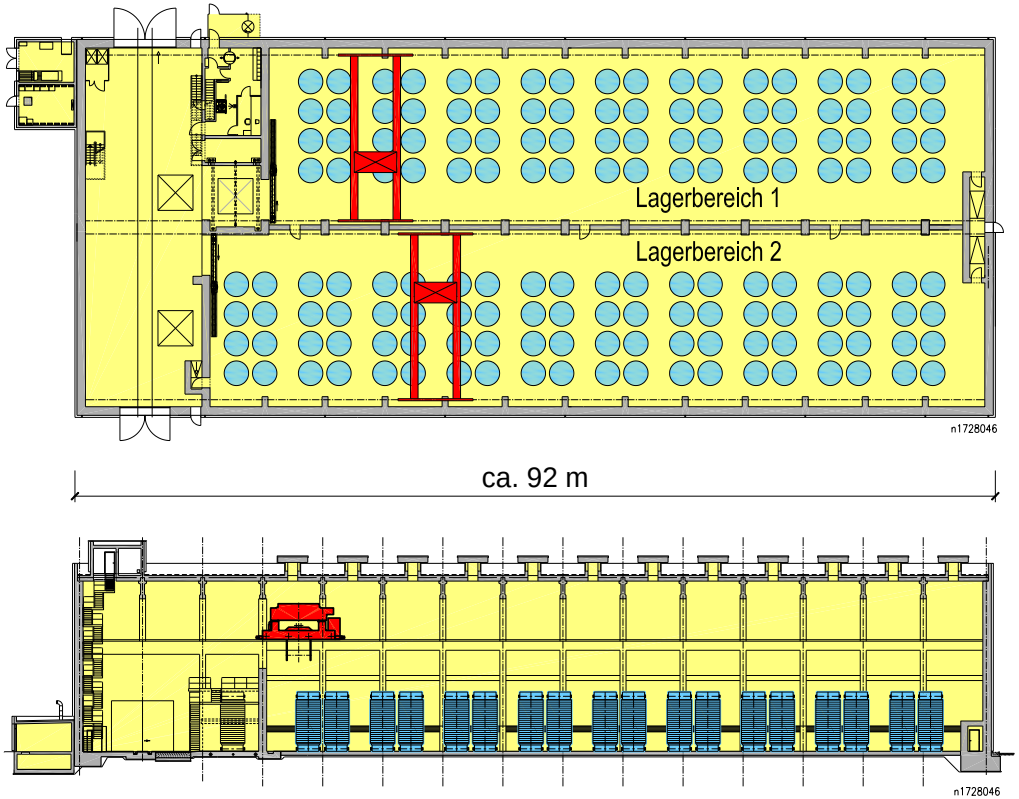
- Design, Transport, Storage of DPCs for SNF and HLW in Germany
- Measurement and Demonstration Programs
- Integrated DPC Safety Case Approach, IAEA
- Aging Considerations
- Inspections before Transport after Storage
- MPC

SNF/HLW Interim Storage Facilities

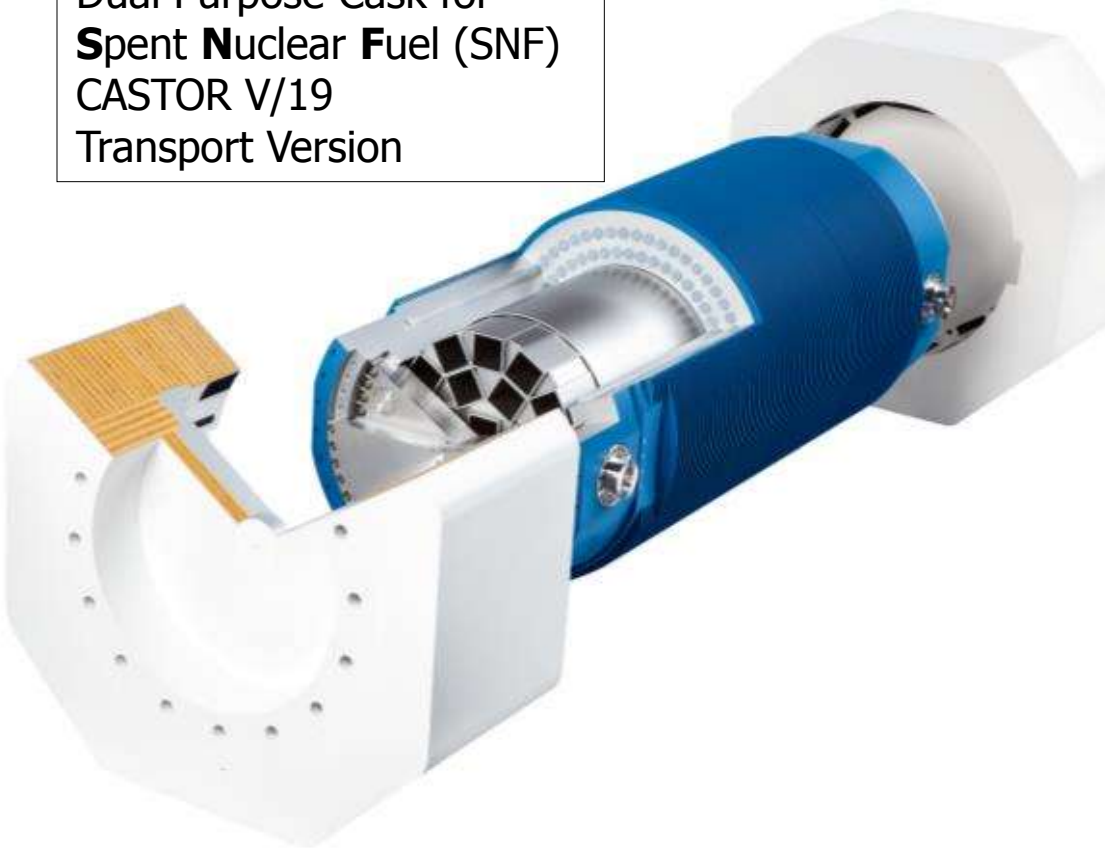
using Dual Purpose casks

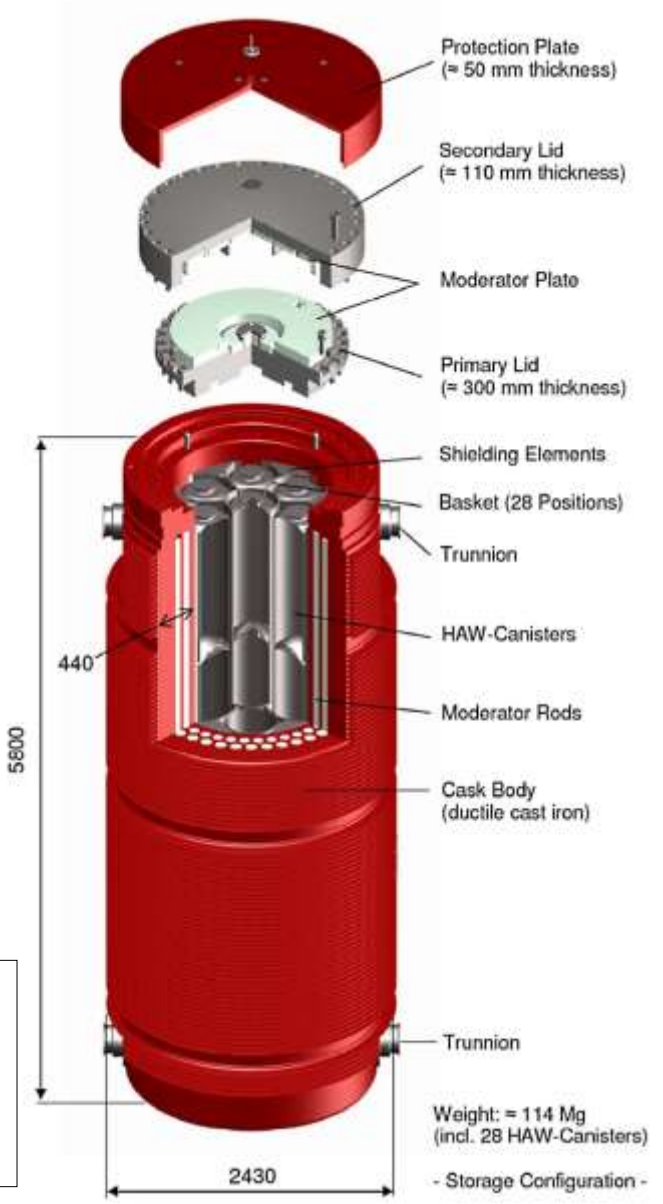
(as constructed, built and operated in Germany)





Dual Purpose Cask for
Spent **N**uclear **F**uel (SNF)
CASTOR V/19
Transport Version





Dual Purpose Cask for
High **L**evel **W**aste (HLW)
CASTOR HAW28M
Storage Version

Photos: GNS

DPC (HLW) Transport Campaigns from France to Germany

Transport of 11 TN85 Casks by Road from La Hague to Valognes, by Rail to Dannenberg and by Road to Interim Storage Facility Gorleben (2008)

Fotos: NCS

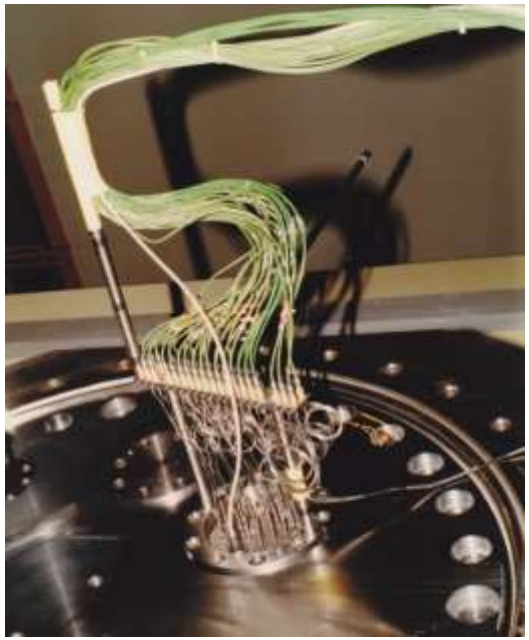
SNF and HLW DPC Storage Facility TBL Gorleben

Current Inventory:
- 108 HLW Casks (1 TS 28V, 74 CASTOR HAW 20/28CG, 12 TN 85, 21 CASTOR HAW28M)
- 5 SNF Casks (1 CASTOR Ic, 1 CASTOR IIa, 3 CASTOR V/19)

Foto: GNS

German Dry Spent Fuel Storage Demonstration & Measurement Programs with different SNF Dual Purpose Cask Designs:

- CASTOR Ib with 4 PWR SNF Assemblies, NPP Stade-WAK Karlsruhe
- CASTOR Ia with 4 PWR SNF Assemblies, NPP Biblis-KFA Juelich
- TN 1300 with 12 PWR SNF Assemblies, NPP Biblis
- CASTOR Ic with 16 BWR SNF Assemblies, NPP Würgassen
- CASTOR AVR with 2 Stainless Steel Canisters, each filled with 950 spherical „Graphite Ball“ AVR Fuel Elements, KFA Jülich
- TN AVR-2 with the same Contents as before, KFA Jülich



Results:

Verification of
- Cask handling operations
- Containment function
- Leakage rates and their measurement methods
- Evacuation, drying and gas filling operations
- Shielding efficiency
- Heat removal
- Fuel rod temperatures
- Fuel rod integrity ; cavity gas sampling

CASTOR Ia with 4 PWR SNF Assemblies
09/1983 – 09/1985

Loading at NPP Biblis

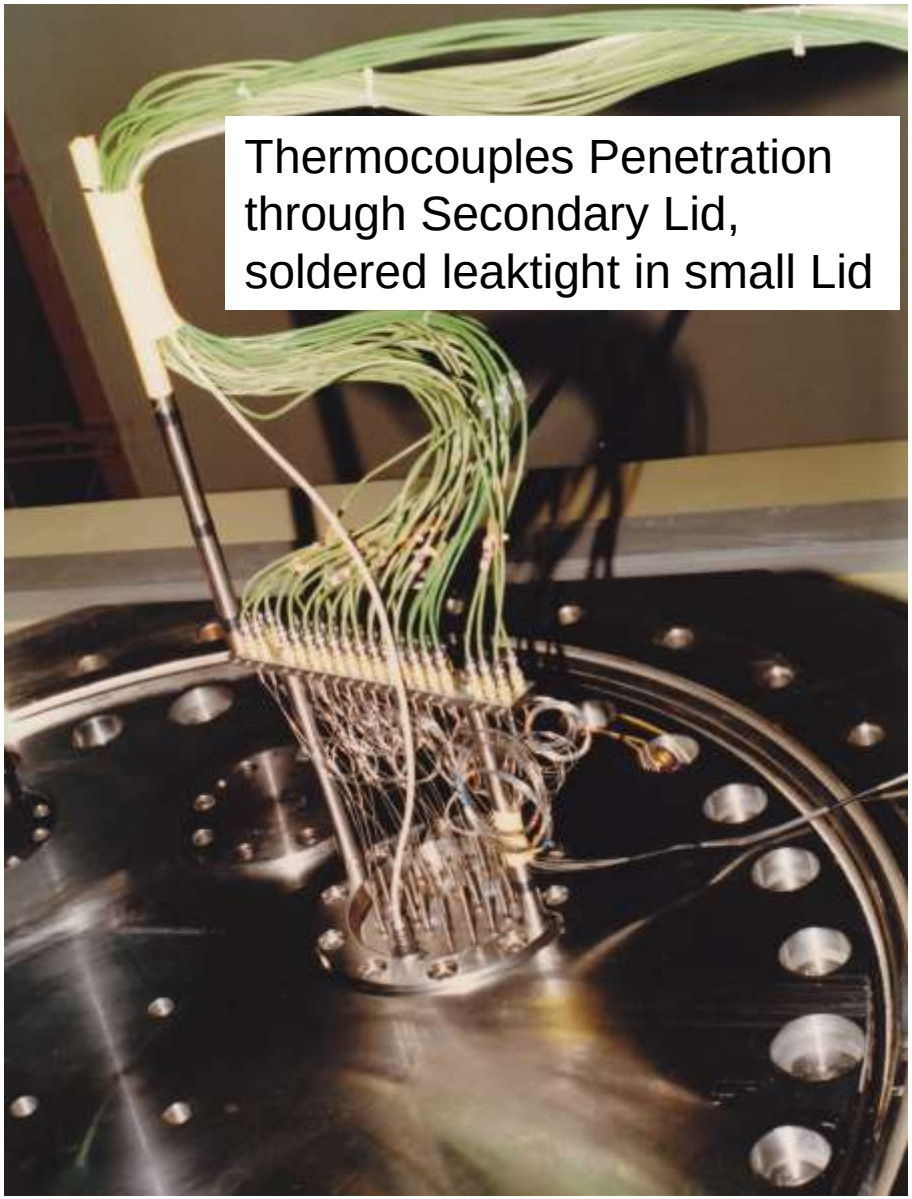
Transport and Transfer into a Hall at KFA Juelich

For transportation with a primary lid penetrated by instrumentation orofices the secondary lid needs to be assessed and approved as transport package containment boundary

…that is the same requirement as for storage casks to have a back-up solution in case of a hypo-thetical loss of primary lid`s leaktightness

Dry SNF DPC Storage Demonstration&Measurement Programs

CASTOR Ia in
Storage Test Position



Thermocouples Penetration through Secondary Lid, soldered leaktight in small Lid

Differences between DPC Transport Package and DPC Storage Cask

….to be considered in their Safety Cases

DPC Transport Package:

- **Impact limiters at bottom and lid side,**

  in some designs also circumferentially

- **Transport in horizontal position, under canopy**

- **Acceptance criteria: SSR-6 (e.g. accident test conditions: 9m drop/1m puncture/30 min fire)**

DPC Storage Package:

- **No impact limiters (on the cask)**

- **Secondary lid/seal with monitoring**

- **Protection lid**

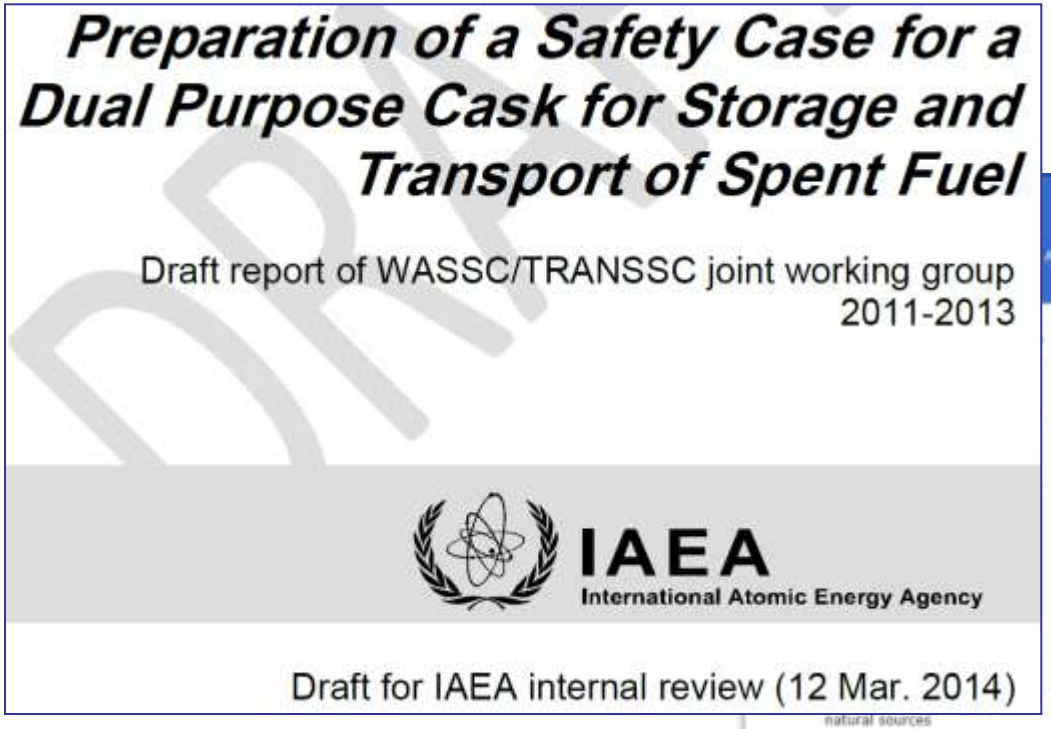
- **Vertical position, inside hall**

- **Acceptance criteria: national storage req.**

  (e.g. on-site transport and handling accidents)

2 Dual Purpose Cask configurations:
Different acceptance criteria lead to different DPC specifications which have ONE „core assembly“ (contents, basket, body, primary lid)

IAEA Document on Preparation of a DPC Safety Case



[WG webpage](http://www-ns.iaea.org/tech-areas/waste-safety/spent-fuel-casks-wg.asp?s=3)
http://www-ns.iaea.org/tech-areas/waste-safety/spent-fuel-casks-wg.asp?s=3

Design considerations *to limit* ***ageing effects*** *(e.g. proper material/component selection) and* ***operational conditions*** *to limit access of damaging agents (e.g. drying/evacuation, humidity control) are important issues of safety assessment, package design and management system approval.*

Component Material	Material	Degradation factors	Design consideration
Neutron shielding	Resin, polyethylene	Thermal, radiation	Establishment of weight loss rate of neutron shield material in shielding analysis.
Basket	Aluminum alloy, boron-aluminum alloy; neutron absorbers	Thermal, radiation	Establishment of allowable stress, considering ageing deterioration in structural and compositional analysis for criticality control.
Metal gasket	Aluminum, silver	Chemical, thermal	Moisture control and establishment of temperature limit of the metal gasket.
Elastomeric O-ring	EPDM, FKM	Chemical, radiation, thermal	Material selection
Cask body	Coating	Chemical	Inspection and necessary maintenance
Trunnions	Polymer sealants	Chemical	Inspection and necessary maintenance

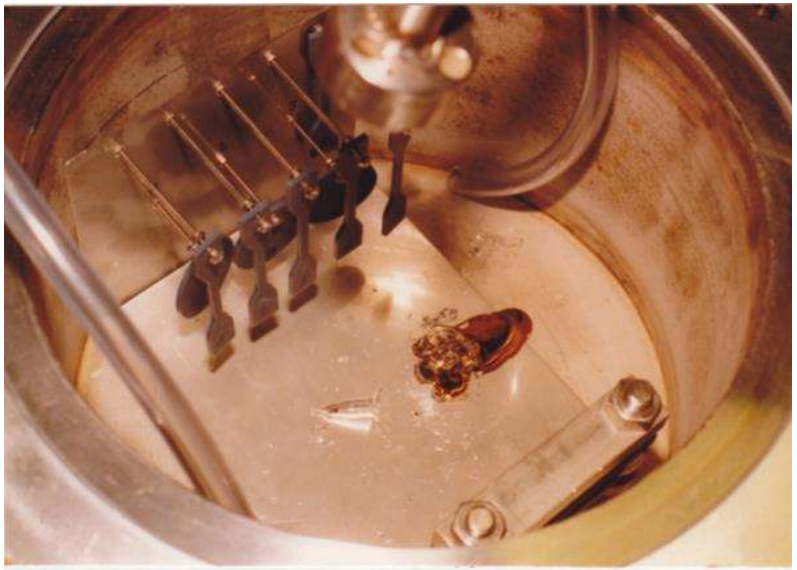
For those components inside the cask and inside the lid closure system, which cannot be changed during the use, it is essential to capture all potential degradation influences at the initial assessment!

From IAEA-TECDOC-DRAFT "Preparation of a safety case for a dual purpose cask containing spent fuel"

Investigation of the influence of Cesium on Lid Closure Components

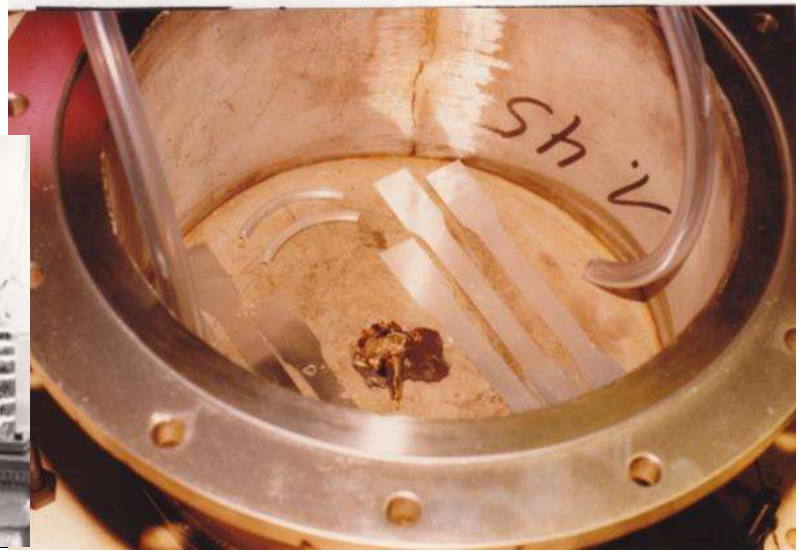
Cs corrosion tests of the lid closures of 9 small heated containers

Can Cesium, released from defective fuel rods, cause corrosion of metal seals?



Cs corrosion test of Aluminum and Silicon specimen

BAM investigations could demonstrate that it is not the case!
(1989-1992)



CASTOR© THTR/AVR

Interim Storage of SNF of decommissioned gas cooled high temperature research reactor in Jülich, Germany

- ✓ Loaded between 1993 - 2009
- ✓ Monolithic ductile cast iron cask body
- ✓ Double lid closure system (permanent pressure monitoring)
- ✓ Metallic seals
- ✓ Upper & lower pair of trunnions
- ✓ Bottom & top impact limiters (steel sheeted, wood filled)
- ✓ 20 years in storage

© FZJ

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Transport preparation of

152 casks is ongoing

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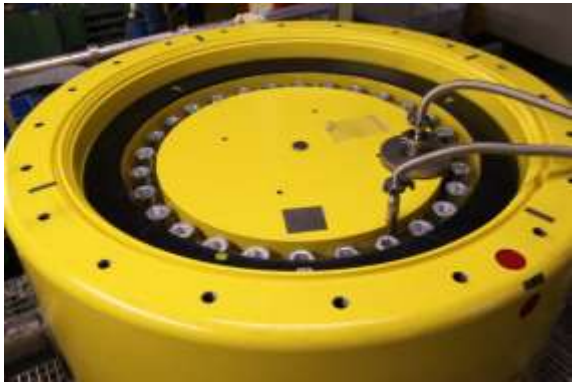
Preparation for transportation to another destination

Example:
Leak-Tightness Test
at Primary Lid



Example:
Repair & Testing
of Trunnions

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(1) Check of documentation of pressure monitoring system ✓

(2) Visual check of surfaces ✓

(3) Block-Position measurement of all lids ✓

(4) Examination of bolting torque of primary lid bolts ✓

(5) Leak-tightness tests of lid systems (33 primary lids) ✓

(6) All seals of 55 reassembled secondary lids renewed and leak-tight tested ✓

(7) Inspections of bolts and threaded holes (one hole repaired) ✓

(8) Check of trunnions, refurbished and replaced, 55 casks load tested ✓

CASTOR© THTR/AVR **fulfills** current regulatory requirements

55 packages were inspected and tested

Transport ability was retained after more than 20 years of storage !

Essentials for ageing management of dual purpose transport packages:

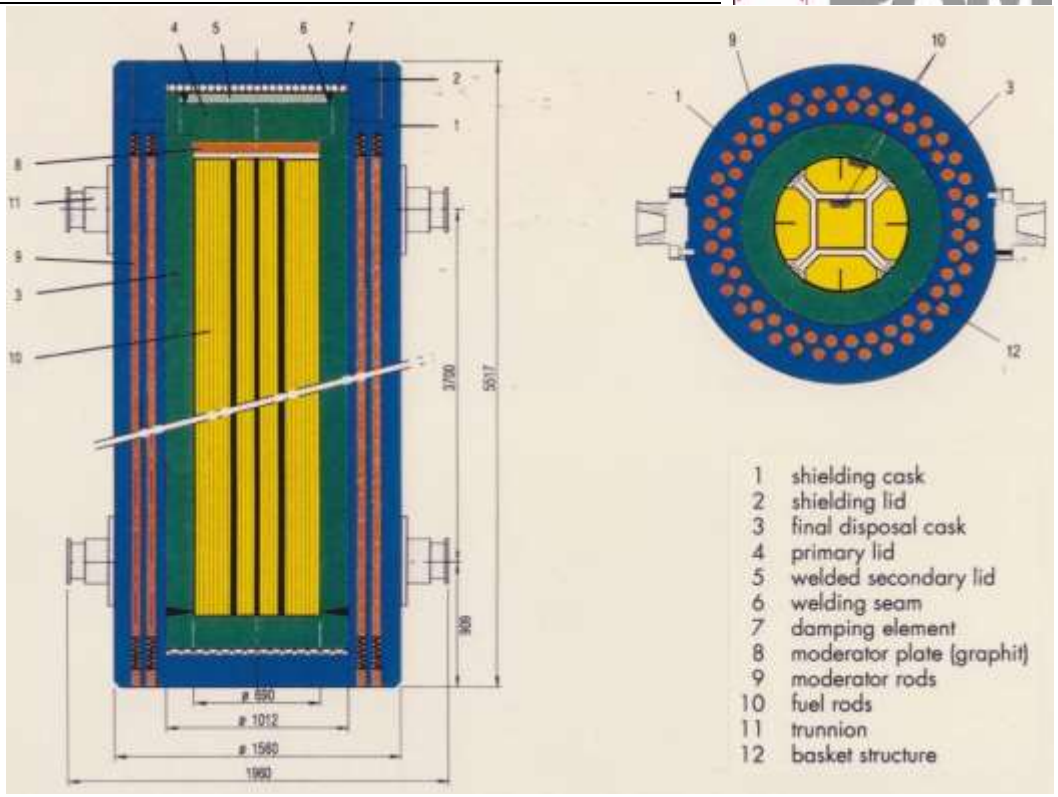
1. **Design that considers ageing resistance of components and materials**
   (materials ageing assessment, effective inner and outer coatings and medium penetration barriers, quality in manufacturing/documentation etc.)

2. **Operational conditions that prevent degradation propagation and ingress of corrosive agents as much as possible**
   (drying, evacuation, inert gas atmosphere etc.)

3. **Periodic package design approval certificate renewal**
   (gap analysis of the safety case, management system adaption etc.)

4. **Inspection program for tests before transport**
   (appropriate selection of measures considering storage experiences etc.)

Drop Test Campaign with a SNF Multi Purpose Cask 1:1 Model (1994)



POLLUX Cask (GNS)
Designed for transport, storage and disposal of spent nuclear fuel